Exhibit B

United States Department of Commerce
National Institute of Standards and Technology

NIST Special Publication 811
1995 Edition

Guide for the Use of the International System of Units (SI)

Barry N. Taylor

BEST AVAILABLE COPY

NIST Special Publication 811
1995 Edition

Guide for the Use of the International System of Units (SI)

Barry N. Taylor

Physics Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-0001

(Supersedes NIST Special Publication 811, September 1991)

April 1995

U.S. Department of Commerce
Ronald H. Brown, Secretary

Technology Administration
Mary L. Good, Under Secretary for Technology

National Institute of Standards and Technology
Arati Prabhakar, Director

National Institute of Standards
and Technology
Special Publication 811
1995 Edition
(Supersedes NIST Special
Publication 811, September 1991)
Natl. Inst. Stand. Technol.
Spec. Publ. 811
1995 Ed.
84 pages (April 1995)
CODEN: NSPUE2

U.S. Government Printing Office
Washington: 1995

For sale by the Superintendent of
Documents
U.S. Government Printing Office
Washington, DC 20402

Preface

The International System of Units, universally abbreviated SI (from the French *Le Système International d'Unités*), is the modern metric system of measurement. Long the dominant measurement system used in science, the SI is becoming the dominant measurement system used in international commerce.

The Omnibus Trade and Competitiveness Act of August 1988 [Public Law (PL) 100-418] changed the name of the National Bureau of Standards (NBS) to the National Institute of Standards and Technology (NIST) and gave to NIST the added task of helping United States industry increase its competitiveness in the global marketplace. It also recognized the rapidly expanding use of the SI by amending the Metric Conversion Act of 1975 (PL 94-168). In particular, section 5164 (Metric Usage) of PL 100-418 designates

> the metric system of measurement as the preferred system of weights and measures for United States trade and commerce . . .

and requires that

> each Federal agency, by a date certain and to the extent economically feasible by the end of fiscal year 1992, use the metric system of measurement in its procurements, grants, and other business-related activities, except to the extent that such use is impractical or is likely to cause significant inefficiencies or loss of markets for United States firms . . .

In January 1991, the Department of Commerce issued an addition to the Code of Federal Regulations entitled "Metric Conversion Policy for Federal Agencies," 15 CFR 1170, which removes the voluntary aspect of the conversion to the SI for Federal agencies and gives in detail the policy for that conversion. Executive Order 12770, issued in July 1991, reinforces that policy by providing Presidential authority and direction for the use of the metric system of measurement by Federal agencies and departments.*

Because of the importance of the SI to both science and technology, NIST has over the years published documents to assist NIST authors and other users of the SI, especially to inform them of changes in the SI and in SI usage. For example, this second edition of the *Guide* replaces the first edition prepared by Arthur O. McCoubrey and published in 1991. That edition, in turn, replaced NBS Letter Circular LC 1120 (1979), which was widely distributed in the United States and which was incorporated into the *NBS Communications Manual for Scientific, Technical, and Public Information*, a manual of instructions issued in 1980 for the preparation of technical publications at NBS.

It is quite natural for NIST to publish documents on the use of the SI. First, NIST coordinates the Federal Government policy on the conversion to the SI by Federal agencies and on the use of the SI by United States industry and the public. Second, NIST provides official United States representation in the various international bodies established by the Meter Convention (*Convention du Mètre*, often called the Treaty of the Meter in the United States), which was signed in Paris in 1875 by seventeen countries, including the United States (nearly 50 countries are now members of the Convention).

* Executive Order 12770 was published in the Federal Register, Vol. 56, No. 145, p. 35801, July 29, 1991; 15 CFR 1170 was originally published in the Federal Register, Vol. 56, No. 1, p. 160, January 2, 1991 as 15 CFR Part 19, but was redesignated 15 CFR 1170. Both Executive Order 12770 and 15 CFR 1170 are reprinted in Ref. [1]. (See Appendix D — Bibliography, which begins on p. 72.)

One body created by the Meter Convention is the General Conference on Weights and Measures (CGPM, *Conférence Générale des Poids et Mesures*), a formal diplomatic organization.** The International System was in fact established by the 11th CGPM in 1960, and it is the responsibility of the CGPM to ensure that the SI is widely disseminated and that it reflects the latest advances in science and technology.

This 1995 edition of the *Guide* corrects a number of misprints in the 1991 edition, incorporates a significant amount of additional material intended to answer frequently asked questions concerning the SI and SI usage, and updates the bibliography. The added material includes a check list in Chapter 11, which is reproduced immediately after this Preface for easy reference, for reviewing the consistency of NIST manuscripts with the SI. Some changes in format have also been made in an attempt to improve the ease of use of the *Guide*.

In keeping with United States and NIST practice (see Sec. C.3), this edition of the *Guide* continues to use the dot as the decimal marker rather than the comma, the spellings "meter," "liter," and "deka" rather than "metre," "litre," and "deca," and the name "metric ton" rather than "tonne."

I should like to take this opportunity to thank James B. McCracken of the NIST Metric Program for his highly capable assistance in the early stages of the preparation of this *Guide*.

March 1995

Barry N. Taylor

NOTE TO SECOND PRINTING

Since the first printing of this Special Publication (April 1995), the 20th CGPM, which met October 9-12, 1995, decided to eliminate the class of supplementary units as a separate class in the SI. Thus the SI now consists of only two classes of units: base units and derived units, with the radian and steradian, which were the two supplementary units, subsumed into the class of SI derived units. This decision by the CGPM relates to p. 1, Sec. 1.2, sixth paragraph; p. 3, Chapter 4, first paragraph; p. 3, last sentence of footnote 2; p. 4, Sec. 4.2.1, first paragraph; p. 7, Sec. 4.3; p. 11, Sec. 5.4; and p. 40, Sec. A.1. This second printing also includes some minor typographical corrections.

** See Ref. [2] or [3] for a brief description of the various bodies established by the Meter Convention: The International Bureau of Weights and Measures (BIPM, *Bureau International des Poids et Mesures*), the International Committee for Weights and Measures (CIPM, *Comité International des Poids et Mesures*), and the CGPM. The BIPM, which is located in Sèvres, a suburb of Paris, France, and which has the task of ensuring worldwide unification of physical measurements, operates under the exclusive supervision of the CIPM, which itself comes under the authority of the CGPM. In addition to a complete description of the SI, Refs. [2] and [3] also give the various CGPM and CIPM resolutions on which it is based. With the exception of Table 8, Tables 1 to 11 of this *Guide* and their accompanying text are taken or are adapted from these references.

More specifically, the three major categories of symbols found in scientific and technical publications should be typed or typeset in either italic or roman type, as follows:

— symbols for *quantities* and *variables*: italic;

— symbols for *units*: roman;

— symbols for *descriptive terms*: roman.

These rules imply that a subscript or superscript on a quantity symbol is in roman type if it is descriptive (for example, if it is a number or represents the name of a person or a particle); but it is in italic type if it represents a quantity, or is a variable such as x in E_x or an index such as i in $\Sigma_i x_i$ that represents a number (see Secs. 10.2.1, 10.2.3, and 10.2.4). An index that represents a number is also called a "running number" [6: ISO 31-0].

Notes:

1 The above rules also imply, for example, that $\mathrm{\mu}$, the symbol for the SI prefix micro (10^{-6}), that Ω, the symbol for the SI derived unit ohm, and that F, the symbol for the SI derived unit farad, are in roman type; but they are in italic type if they represent quantities (μ, $\mathit{\Omega}$, and F are the recommended symbols for the quantities magnetic moment of a particle, solid angle, and force, respectively).

2 The typeface for numbers is discussed in Sec. 10.5.1.

The following four sections give examples of the proper typefaces for these three major categories.

10.2.1 Quantities and variables — italic

Symbols for quantities are italic, as are symbols for functions in general, for example, $f(x)$:

t=3 s	t time, s second	T=22 K	T temperature, K kelvin
r=11 cm	r radius, cm centimeter	λ=633 nm	λ wavelength, nm nanometer

Constants are usually physical quantities and thus their symbols are italic; however, in general, symbols used as subscripts and superscripts are roman if descriptive (see Sec. 10.2.3):

N_{A}	Avogadro constant, A Avogadro	R	molar gas constant
θ_{D}	Debye temperature, D Debye	Z	atomic number
e	elementary charge	m_{e}	m mass, e electron

Running numbers and symbols for variables in mathematical equations are italic, as are symbols for parameters such as a and b that may be considered constant in a given context:

$$y=\sum_{i=1}^{m} x_i z_i \qquad x^2 = ay^2+bz^2$$

Symbols for vectors are boldface italic, symbols for tensors are sans-serif bold italic, and symbols for matrices are italic:

$\boldsymbol{A}\cdot\boldsymbol{B}=\boldsymbol{C}$ (vectors) $\qquad$ $\boldsymbol{\mathsf{T}}$ (tensors) $\qquad$ $A=\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22}\end{pmatrix}$ (matrices)

Symbols used as subscripts and superscripts are italic if they represent quantities or variables:

c_p p pressure $\qquad$ q_m m mass $\qquad$ σ_{Ω} $\mathit{\Omega}$ solid angle $\qquad$ ω_z z z coordinate

10.2.2 Units — roman

The symbols for units and SI prefixes are roman:

m	meter	g	gram	L	liter
cm	centimeter	µg	microgram	mL	milliliter